

books so beautifully illustrated. The author's method has the merit of inaugurating a comparison of the minute anatomy of the nervous system by enabling the reader to see the structures which he has discovered as he saw them; and hence the book will always be a valuable work of reference; and it will certainly induce others to hand on the torch of knowledge in a like excellent way.

*Memoirs of the Geological Survey of India. Palæontologia Indica, being Figures and Descriptions of the Organic Remains procured during the progress of the Geological Survey of India.* Published by order of his Excellency the Governor-General of India in Council. Series x. *Indian Tertiary and post-Tertiary Vertebrata.* Vol. II. Part 1. *Sivalik Rhinocerotida.* Part 2. *Supplement to Sivalik and Narbada Proboscidea,* with 11 plates: 1881. Part 3. *Sivalik and Narbada Equida,* with 5 plates: 1882. Part 4. *Sivalik Camelopardalida,* with 7 plates: 1883. Part 5. *Sivalik Selenodont Suina &c.,* with 3 plates: 1883. By R. LYDEKKER, B.A., F.Z.S., Geological Survey of India. Calcutta: the Geological Survey Office. London: Triübner & Co.

THE five parts published of the second volume of the Indian Tertiary Vertebrata are all by Mr. Lydekker, and devoted to Sivalik fossils. The volume will apparently include other parts, but already extends to 176 pages and 25 plates. There is no reason for the association of the parts in the way in which they are issued, and every part has a separate pagination as well as the pagination of the volume; the plates take the numbering for the volume only. On account of the wealth of material and interest of the types described, this work will always be important in palæontology; and we cannot help believing that its value is enhanced by the manner of dealing with the systematic part of the subject which the author has adopted, for the aims of science are certainly better served by making genera large and then showing the characters wherein the species differ from each other, than by adopting the too common method of subdividing genera till the evidences of their mutual dependence and of the evolution of species are obscured. If any one should observe that the author has not always adhered to so excellent a plan, it must be conceded that when the materials are scanty and the types such that their true nature cannot be worked out, then it becomes permissible to formulate whatever knowledge is available by a nomenclature which shall not prejudice affinities.

It is almost impossible to separate the fossil forms of rhinoceros from those which still live. Dr. Falconer detected the hornless rhinoceros, which he named *Acerotherium perimense*, and to this species Mr. Lydekker now refers the *Rhinoceros planidens* and *R. iravadicus*, which he has defined in the former volume: the teeth approach those of the rhinoceroses of Sumatra and Java. This is the only occurrence of *Acerotherium* in the Sivalik beds. The other

fifteen fossil species, according to Mr. Lydekker's table, all occur in the Miocene rocks of Europe and North America. Some contribution is made to the knowledge of *Acerotherium* in the description of a cranium, of which the author gives a restoration. As compared with the *Acerotherium incisivum*, the Indian species has the nasal bones thicker at the base and apparently shorter; there is a greater depth from the dental border of the orbit to the teeth; the temporal fossæ in the Indian form are wider and shorter, and other differences help to distinguish the species. The dentition is described in detail, from which it appears that there are four premolar teeth and three true molars, while in front of the premolars there is the root of an incisor. These teeth are characterized by a well-marked cingulum, which distinguishes this animal from the associated species of rhinoceros, though the cingulum is well developed in the *Rhinoceros deccanensis* of Foote.

Having compared the dentition with such types as were likely to throw light upon the species, the author passes on to the genus *Rhinoceros*, recognizing thirty species living and fossil, of which the four Siwalik species defined by Dr. Falconer still remain the only Indian types from this horizon. The author commences with some notice of the *Rhinoceros sivalensis*, affirming that the species is not hexaprotodont, describes some molar teeth, and points out resemblances between the molars of this species and those of *Rhinoceros javanicus*, and observes that the only character by which he can distinguish the molars of the living and fossil form is a difference in the relative dimensions of the teeth—the greatest width of the anterior surface being exactly equal to the greatest length of the external surface in the molars of *R. sivalensis*, whereas in *R. javanicus* the anterior measurement is greater than the external measurement; so that, were it not for the difference in form of the skull, the author doubts whether a specific difference could be established on the character of the teeth. This tooth-character is of some interest, since *Acerotherium* and all the Miocene species of *Rhinoceros* possess teeth of the type represented at the present day by the rhinoceros of Sumatra, which approximates towards the teeth of *Palæotherium*, *Anchitherium*, *Hyachyus*, and other old Perissodactyles; and on this circumstance Mr. Lydekker relies in explaining the resemblance between the milk-molars of the Sumatran and Indian types, because ancestral characters are often retained in the deciduous teeth long after they are lost in the permanent teeth. Hence he refers all species which approximate to the *Rhinoceros indicus* to a comparatively recent origin, the oldest form, *Rhinoceros platyrhinus*, only occurring in such parts of the Siwalik beds as are of Pliocene age. An excellent critical discussion of the mandible results in the conclusion that the form hitherto referred to *Rhinoceros palæindicus* must be assigned to the *Rhinoceros sivalensis*, partly because there is no known unicorn species without lower incisors, and partly because the platyrhine type of jaw is found in the beds which yield the molars of *Rhinoceros sivalensis*, but also because in form the jaw and teeth so closely resemble "the corre-

sponding parts of *R. javanicus* that it would be but a waste of words to give a detailed description." A variety of *Rhinoceros sivalensis* which occurs in the Gaj beds of Miocene age, in Western Sind, is described by Lydekker under the name of *gajensis*. It is known from the hinder half of the skull, in which the supraoccipital angular ridge is of moderate height and the molar teeth are seen.

*R. sivalensis* is apparently a unicorn species with a cranium intermediate between *R. indicus* and *R. javanicus*; and though its molars are like the teeth in the latter species, it is distinguished by wanting the median lower incisors. The fossil form is regarded as the ancestor of its living ally. The second species, *R. palæindicus*, appears never to have been described by Falconer, and the author now gives some account of the skull, molars, and mandible. It is found throughout the sub-Himalayan Siwaliks, from the Ganges to the Indus, but is rare in the Punjab. The true molars are distinguished from those of *R. sivalensis* by the greater flatness of the external surface of each tooth, due to the absence of a buttress at the antero-external angle. A small skull in the British Museum presents some variation in the premolars, but the author refers it to *R. palæindicus* on account of the form of the head.

The third species of *Rhinoceros* (*R. platyrhinus*) also was left undescribed by Falconer. It is a two-horned species with very wide and thick nasals, and with the supraoccipital region produced into a high crest; and presents no affinities with the *R. sumatrensis* or with the Miocene *R. Schleiermacheri*. Among the European fossil species the nearest correspondence is seen in the *R. tichorhinus*; but the European species is distinguished by having a nasal septum.

Finally, in his remarks on the pedigree of the Indian species of rhinoceros the author observes that *R. javanicus* is probably the descendant of *R. sivalensis*, that the rhinoceros from the Pleistocene deposits of the Narbada valley is practically identical with the *R. indicus*, and that no species in the Siwalik Pliocene beds can be regarded as the direct ancestor of *R. indicus*, the fossil form *R. palæindicus* being exactly intermediate between the Sumatran or *Acerotherium* type and *R. indicus* in its molars. The *Rhinoceros sumatrensis*, which is well known to closely resemble the *R. Schleiermacheri*, is supposed to have descended with it from a progenitor which is still unknown. The group to which the *R. platyrhinus* belongs is still uncertain, for it had not the aborted premaxilla of the Pikermi and African species, from which it is also distinguished by the union of the inferior squamosal processes; yet in the form of its upper molars it closely agrees with *R. simus*. The Pleistocene *R. deccanensis* is inferred to be a bicorn species from its mandible. The paper concludes with a list of the more important memoirs on *Acerotherium* and *Rhinoceros*, and is illustrated with ten plates, which are almost entirely representations of teeth.

The supplement to Siwalik and Narbada Proboscidea gives a brief account of fragments of maxilla and mandible of the *Dinotherium indicum* from Perim Island; and the *Mastodon pandionis* is better

known by the occurrence of three mandibles from Perim Island and the Punjab. The author further quotes from Dr. Naumann the occurrence in Japan of the Indian proboscideans *Stegodon Clifti* and *Stegodon insignis* or *bombifrons*, and the *Elephas namadicus* and apparently *Elephas primigenius*. The two *Stegodons* were previously known to range into China; and the occurrence of these forms in Japan would indicate that the Siwalik and Narbada elephants ranged northward into a region which now belongs to the palaearctic province.

The Indian fossil horses comprise two species of *Hippotherium* and two of *Equus*, all of which are known chiefly from the teeth, though a few bones of the extremities and a more or less complete skull or two have been found. In the early stage of wear the upper molar teeth of *Hippotherium* are distinguished by complete isolation of the anterior pillar, though in well-worn teeth this pillar becomes united to the crescent, as in *Equus*. The *Hippotherium antilopinum* named by Falconer may possibly, as Owen suggested and Von Meyer urged, be identical with the *H. gracile* of Europe—a resemblance which was recognized by Prof. Gaudry, though he was afterwards led to think this species monodactyle. The American species of *Hippotherium* have a simpler structure of the enamel folds. The second species of this genus is the *Hippotherium Theobaldi* of Lydekker. It is distinguished from the foregoing by a much greater proportionate length of the milk-molars, and has the anterior pillar of the tooth compressed so as to be longitudinally elongated, and the posterior pillar extends back to the hinder border of the crown. The enamel is but slightly folded and the cement thin; yet the author observes that if the milk-molars had not been known, it would have been doubtful whether the true molars would have afforded ground for the formation of two species.

Among the limb-bones are some more or less complete feet; a fore limb which is figured shows the lateral digits about as well developed as in the stout variety of the Pikermi Hippothere figured by Professor Gaudry; and it is evident that the lateral metacarpal bones were not blended with the median metacarpal, at least at their distal end. The horses, as Mr. Lydekker observes, are not to be easily distinguished in a fossil state from asses. The Indian *Equus sivalensis* has the anterior pillar of the tooth smaller than in *Equus caballus*; but the remains indicate an animal at least 15 hands high. The *Equus henionus*, or the Kiang of Thibet, has upper molars so like those of *sivalensis* that the author believes it would be impossible to distinguish them if both occurred in the same fossil state. There is a distinct trace of a 'larmial' cavity in the skull, which is developed in the hippotheres and unknown in living horses. The second horse is the *Equus namadicus* of Falconer, with which is now united the *Equus palwonus*. It is distinguished by the upper molars having a greater length of grinding-surface of the anterior pillars, and it is distinguished from all living horses by the square crowns of the upper milk-molars. In the living horse the plication of the enamel is always less than in the *E. namadicus*. It appears to be associ-

ated with the *Bubalus palavindicus* and *Camelus sivalensis* in the top beds of the Siwaliks. The memoir concludes with a bibliography of *Equus* and *Hippotherium*, and five plates representing teeth and a foot.

Mr. Lydekker regards the giraffes and sivatheres as forming one family, the Camelopardalidæ, which includes the genera *Camelopardalis*, *Orasius*, *Vishnutherium*, *Helladotherium*, *Hydaspitherium*, *Bramatherium*, and *Sivatherium*. The author believes that this group is most closely allied to the deer, though the views of Rüttimeyer are subsequently quoted as to the horns being intermediate between true antlers and true horns. Rüttimeyer follows Murie in uniting the Sivatheres with the antelopes because the parietal region is shortened, as in the oxen and the gnu; but the author observes that a skull now referred to *Helladotherium* was referred by Falconer and Murie to a female *Sivatherium*, and the transition from the *Sivatherium* to the giraffe seen in the bones of the limbs and neck and the presence of lachrymal vacuities in the giraffe and *Hydaspitherium* afford evidence of close relationship between these animals. The family is characterized by a reticular or rugose structure of the enamel of the molar teeth. Horns are unknown in *Helladotherium*; but the absence of a burr appears to prove that the large antlers of *Bramatherium* and *Sivatherium* were permanent. The fossil giraffes of Europe are of Miocene age; but the *Camelopardalis sivalensis* of the Siwaliks belongs to the Pliocene period. Teeth, vertebræ, and limb-bones are described, with the conclusion that the animal was about the size of the living species, the neck and limbs having attained their characteristic elongation in the Pliocene age.

*Vishnutherium* is a ruminant of giraffe type known from molar teeth, metatarsus, and cervical vertebræ. The jaw is slender, the molar teeth are larger than those of the giraffe, have a distinct cingulum on the outer surface, and a relatively large tubercle in the median valley of the first and second molars. The teeth are larger than those of the elk, but somewhat resemble them. The metatarsus is longer and slighter than the metatarsus of *Sivatherium*. The sixth cervical vertebra is shorter than the corresponding vertebra of the giraffe and longer than that of *Sivatherium*.

*Helladotherium* appears to be represented by the Pikermi species *H. Duvernoyi*. It is known from the cranium, which was identified by Professor Gaudry. *Hydaspitherium* is a new genus, to which the author refers two species, *H. megalcephalum* and *H. grande*. The former is known from a nearly complete cranium wanting the horn-cores. It has a large subquadrate compound base for the horns immediately in front of the occipital crest, and has a large lachrymal cavity, which is wanting in *Sivatherium*. The teeth differ from those of *Sivatherium* in being smaller, in having a finer texture of outer surface, in the absence of plication of the enamel of the central pit, and the less development of costæ on the external surface of the lobes. The teeth are very similar to those of *Bramatherium*; and the author remarks that if there were no evidence but the teeth, *Hydaspitherium*, *Helladotherium*, and *Bramatherium* might all be



merged in one. Mandible, molars, limb-bones, and vertebræ are described in so far as is necessary to illustrate the differences of the genus from *Sivatherium*; and these structures show that in length of limb it was nearest to *Hulladotherium*, in structure of horns nearest to *Sivatherium*, and that in length of neck it is nearer to *Vishnutherium* and the giraffe than to the Sivatheres. The *Hydaspi-therium grande* is known from upper molars, mandible, calcaneum, and a proximal phalange. The author considers it possible that more abundant materials may place the species in a new genus.

*Bramatherium* is another genus of four-horned ruminants, distinguished by the arrangement of the horns. The only species known is the *B. perimense* of Falconer, and no new specimens have been found since the type was first described by that author. The horns, as is well known, consist of a conjoined anterior pair rising between the orbits and a second pair of large size rising from distinct bases at the sides of the occiput.

*Sivatherium giganteum* is only noticed in so far as Mr. Lydekker's views differ from those of previous writers, and to describe some teeth, vertebræ, and metapodial bones. The author differs from Dr. Murie, who regarded *Sivatherium* as most nearly allied to *Antilocapra*, because it is only in *Sivatherium*, the giraffe, the Irish elk, the true elk, and some other deer that the lobes of the molars are oblique to the long axis of the teeth, so as to overlap one another, while their enamel has a rugose structure. In *Antilocapra* and all cavicorn ruminants the enamel of the molars is nearly smooth and the lobes of the teeth are always set straight, so as never to overlap. The memoir concludes with seven plates, illustrative of teeth, cervical vertebræ, and metapodial and podial bones.

The term Selenodont Suina is used to define an extinct group of pig-like Ungulata which have the inner pair of cusps of the upper molars of crescentic form; and this group in India comprises *Anthraco-therium* and *Hyopotamus*, which the author believes may eventually have to be united. Another family is represented by *Mico-therium*, and a third by *Diplopus*. The second or tetracuspitate division of the Selenodont group comprises the Merycopotamidæ and the Oreodontidæ, and a third division includes the Anoplotheres. The author observes that the Hyopotamids pass insensibly into the genus *Cainotherium*, which is a true ruminant; but the Oreodons are probably the progenitors of the ancestors of the camel, and the Anoplotheres are as closely related to the ruminant Xiphodons. Feeding for the most part on food that required fine trituration, their snouts are shorter than in the true pigs.

The account of the Anthracotheridæ, which belong to a group in which the upper molars have five cusps, commences with the typical genus *Anthraco-therium*, which is met with throughout the Pliocene period. The Indian forms are *Anthraco-therium hyopotamoïdes* of Lydekker and *Anthraco-therium silistrense* of Pentland. This latter species, which has numerous synonyms, is known from the upper molars, which were first figured by the Geological Society in 1829, and the mandible. The second species is founded on an upper

molar tooth which has some characters approximating it to *Hypopotamus*. *Hypopotamus* is widely distributed in America, India, and Europe. Both the Indian species *Hypopotamus giganteus* and *H. paleindicus* are of older Pliocene age; they are both known from molar teeth and fragments of the mandible, so that beyond presenting very characteristic shapes they do not throw much light upon this generic type. The tetracuspidate *Merycopotamus dissimilis* was a four- or five-toed pig about the size of a wild boar. The anterior premolars are pointed, like those of *Anthracotherium* and *Hippopotamus*, and the cranium greatly resembles that of the latter genus, and in so far as it diverges from *Hippopotamus* it approximates to *Anthracotherium*; yet the author is disposed, from the character of the molars, to think it most closely related to the Anthracotheridæ and Oreodontidæ. *Cheromeryx silistrensis* is only known from a fragment of a jaw with three molars. *Hemimeryx Blanfordi* is a new type founded upon isolated molar teeth; it is most closely related to *Cheromeryx* and *Merycopotamus*, and has some relation to the Anoplotheres. *Sivameryx sindiensis* is another type founded on isolated teeth; it is larger than *Cheromeryx*, and also resembles *Merycopotamus*. The Oreodonts are represented by a species of the American genus *Agriochœrus*; and the ruminant section is indicated by a single molar named *Pro-palœomeryx sivalensis*, and is considered to be most nearly related to a European species of *Palœomeryx*, and to form a link between the giraffe and the true deer. The memoir concludes with the usual bibliography, and is illustrated with three plates of teeth.

It is difficult to speak of Mr. Lydekker's merits as an anatomist, for he is unfortunate in having published work that was immature, so that now the corrections are unpleasantly numerous; but then the scientific fidelity of which these corrections are evidence is no small merit. We cannot so unreservedly commend the author's method; his critical acumen is excellent, but he does not always seem at his ease in dealing with the writings of others. Frequently voluminous discussions occur when the same result might have been attained in a few sentences. And the memoirs seem written on the supposition that the reader has the resources of the Indian Museum before him, and that the illustrations leave nothing to be desired. In other words, there is not that laborious description of materials other than teeth which we think necessary; and the result is that we are often unable to judge critically of much of the author's labours or to use them fully. If it should be urged that they make no pretence to be more than contributions to palæontology made for the Geological Survey of India, we would say that the acumen displayed by the author leads us to believe him capable of work of a yet higher order, and that science does not gain by restricting the palæontologist to the task of being a lantern-carrier for his geological comrade. The memoirs, however, are valuable contributions to palæontology; and the author is to be congratulated on the progress made with a difficult subject.